CLAIMS

1. A fuel pump arrangement for delivering high pressure fuel to an associated engine, the fuel pump arrangement including three or more pumping plungers (16), each having an associated pump chamber (22) and return biasing means (32) for effecting a return stroke of the plunger (16), and an associated cam (28) for driving the plunger to perform a pumping stroke against the return biasing means (32), during which pumping stroke fuel within the pump chamber (22) is pressurised, wherein each cam (28) is oriented relative to each other cam, the fuel pump arrangement being characterised in that each cam (28) has a surface (50) shaped such that the associated plunger return stroke is interrupted to define a plurality of steps of plunger movement, each step of plunger movement being substantially synchronous with the pumping stroke of another of the plungers (16), thereby to reduce negative torque loading of the camshaft.

2. The fuel pump arrangement as claimed in Claim 1, wherein each cam surface (50) is shaped to include a rising flank (50a) and a falling flank, the falling flank having a plurality of irregularities defining the steps of plunger movement, and wherein the cams (28) are mounted upon the engine camshaft, in use, at angularly offset locations to ensure the or each step of movement through a plunger return stroke substantially coincides with the pumping stroke of one of the other plungers (16).

3. The fuel pump arrangement as claimed in Claim 1 or Claim 2, wherein each cam surface (50) is shaped to define a number of steps of movement through the plunger return stroke that is equal to the number of other plungers (16) in the pump arrangement.

4. The fuel pump arrangement as claimed in Claim 1 or Claim 2, wherein each cam surface (50) is shaped to define a number of steps of movement through the plunger return stroke that is less than the number of other plungers (16) in the pump arrangement.

5. The fuel pump arrangement as claimed in any one of Claims 1 to 4, wherein

each cam surface (50) is shaped such that there is a relatively long period of top dwell prior to commencement of the return stroke.

6. The fuel pump arrangement as claimed in Claim 5, wherein top dwell is arranged to continue until about 90 degrees of cam rotation relative to a cam reference position at or close to commencement of the pumping stroke for said plunger (16).

7. The fuel pump arrangement as claimed in any one of Claims 1 to 6, wherein each cam surface (50) is shaped such that there is a relatively long period of bottom dwell prior to commencement of the pumping stroke.

8. The fuel pump arrangement as claimed in Claim 7, wherein bottom dwell is arranged to occur between about 300 and 360 degrees of cam rotation relative to a cam reference position at or close to commencement of the pumping stroke for said plunger (16).

9. The fuel pump arrangement as claimed in any one of Claims 1 to 8, wherein the return biasing means (32) includes a return spring.

10. The fuel pump arrangement as claimed in any one of Claims 1 to 9, wherein each of the plungers (16) forms part of a unit injector, including a unit housing (13) for the plunger (16) and an associated injector, and whereby the pump chamber (22) associated with each unit injector is arranged to deliver fuel to the associated injector, and to no other injector.

11. The fuel pump arrangement as claimed in any one of Claims 1 to 9, for use in a hybrid unit/pump injector-common rail fuel injection system, including a common rail from which fuel is delivered to the pump chambers (22) of the unit injectors under the control of a control valve.

12. A cam arrangement for use with the high pressure fuel pump arrangement as claimed in any one of Claims 1 to 11.

13. A single cam for use in the cam arrangement as claimed in Claim 12.